AMATEUR WORK

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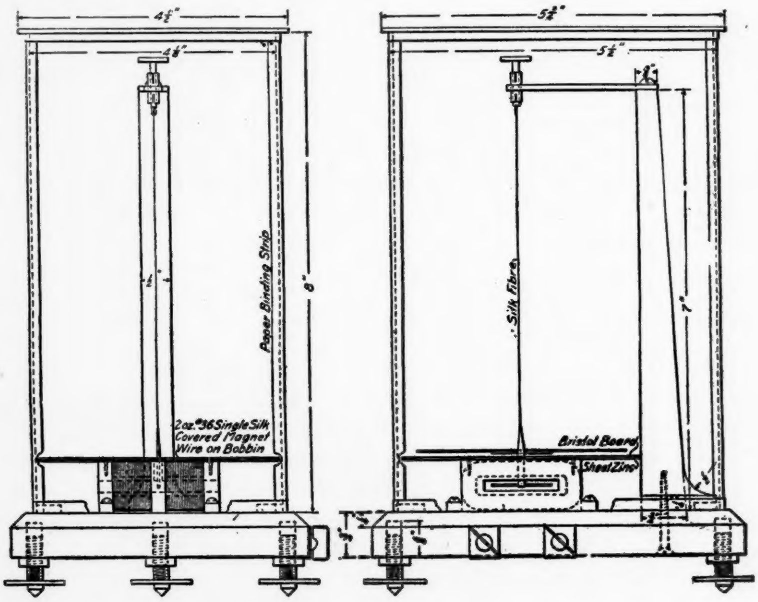
A SENSITIVE GALVANOMETER.

R. G. GRISWOLD.

In measurements of resistance by means of the Wheatstone bridge, to be described later, it is essential that the galvanometer used should be very sensitive, so that it may detect either the presence of an extremely small current or indicate the slightest variation in the strength of a current flowing. One of the most sensitive galvanometers which lends itself to easy construction is the astatic type, the magnetic system of which consists of two magnetic needles rigidly mounted on one vertical axis, with poles reversed. Its sensibility depends upon three conditions: Highly magnetized needles, small controlling force, and a large number of turns on the galvanometer bobbin. Two side elevations of this instrument are shown in Fig. 1, and a plan view in Fig. 2.

The bobbin, Fig. 3, upon which the wire is wound, should be made of some fine-grained hard



wood, such as cherry. It can be worked out to the best advantage with a fret saw and a file. The construction will be greatly facilitated if the form is divided on the line a b and then glued together after the two parts are completed. Give it one coat of shellac and see that the space in which the

lower needle swings is smooth and free from hairs from the brush, pieces of lint or other small obstructions that would interfere with the delicate action of the suspended system. Wind the bobbin with 2 ounces of No. 36 single silk-covered magnet wire, winding one side full first and then the other, so that the current will flow in the same direction about both coils.

Mount the coil upon the base, carrying the wires from the bobbin coil terminals down through holes to grooves cut in the bottom of the base, and thence to the binding screws on the side to the clips of which they are soldered. The dial

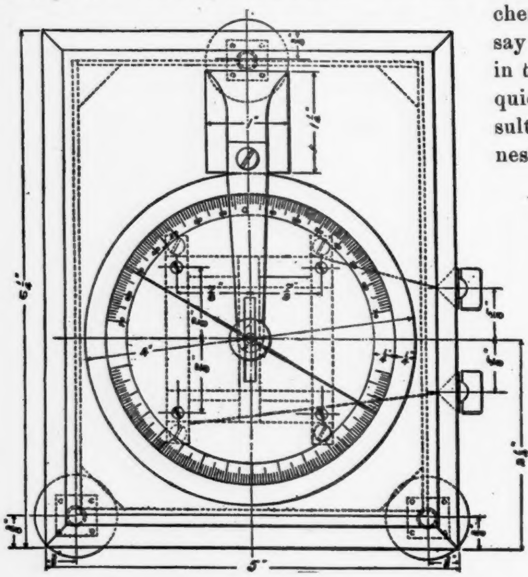


FIG. 2.

is made by gluing a piece of thin white bristol board or other hard-surface paper to a piece of sheet zinc. After the dial is cut to size the circles and divisions should be drawn thereon, numbering the latter by tens. As the instrument is not intended for measuring by deflections in degrees, it is not necessary that the divisions have any particular value other than that they are equal. Fasten the dial to the bobbin by the screws shown so that the center of the dial coincides exactly with the center of the bobbin.

The vertical post is made of wood and has mounted at the top a brass arm, Fig. 4 *a*, carrying at its end an adjustment device for the suspension fiber. A small piece of brass tubing which just fits the brass rod of the hook pin, is soldered in the end of the arm, and fine saw slits are cut at right angles in the top and bottom to permit a slight binding on the pin by squeezing them together slightly. The hook pin, Fig. 4 *b*, should work smoothly, but be held with sufficient friction to stay in any position.

The magnetic system, Fig. 5 *a*, is composed of four very fine sewing needles and a glass fibre mounted between two very thin pieces of mica by means of shellac. Secure four of the finest sewing needles possible, and file off the points and heads until they are 1 in. long. Get from some chemist or druggist a small piece of glass tubing, say 2 or 3 inches long. Heat about an inch of it in the middle in a gas flame until very soft and quickly pull it out at arm's length, which will result in a very fine thread of glass from the thinnest straight portion of which cut a piece 3½ in.

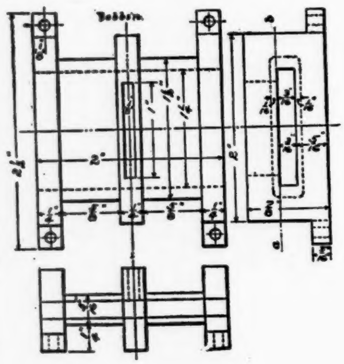


FIG. 3.

long. Cut a small piece of mica to the shape shown at *b*, Fig. 5, and with a very thin knife blade split off two very thin sheets. Draw the positions of the needles, glass fiber and mica stirrup on a piece of white paper. Fasten one strip of mica to the paper in the position drawn, by means of a little wax or soap, and then lay the needles and glass fiber on the mica in their respective positions, having first put a small drop of shellac on the spots where they cross the mica. Put a small drop of shellac on top of the needles and lay the remaining piece of mica on them, placing a small weight on it until the shellac has dried. Fasten the silk suspension fiber in the pointed end of the stirrup in the same manner,

raising the lower side of the stirrup up by means of a piece of paper until the fiber is on a center line passing through the center of the needles. A small weight will serve to keep the two pieces of mica together until they have been firmly cemented to the fiber. Fig. 5 *c*, shows the end view of this stirrup drawn to a larger scale.

The silk fiber can best be obtained from a wire wound silk banjo bass string. By unwinding the wire from the string a long, fine fiber can be drawn out, which, being unspun, will have an equal torsional effect for either direction of swing from the zero point. The balance of the silk, as well as the fine wire, should be wrapped on a card for future use.

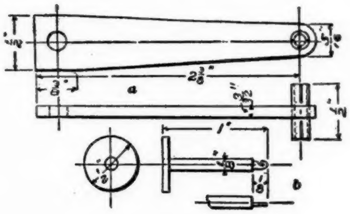


FIG. 4.

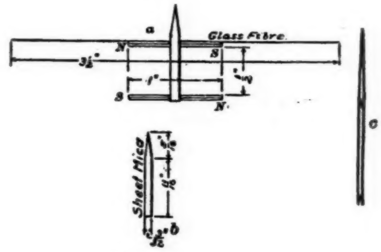


FIG. 5.

The levelling screws, Fig. 7 *a*, are made by forcing the unthreaded end of the screw into the disk *b*, soldering if necessary. The square piece *c* is threaded and fastened to the bottom of the base, $\frac{1}{4}$ in. holes being bored into the wood to accommodate the end of the screw.

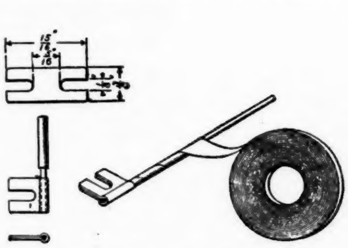


FIG. 6.

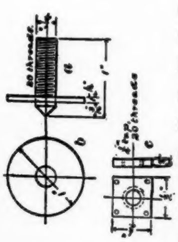


FIG. 7.

The instrument being finished and assembled, it is now ready to receive the magnetic system. To magnetize the needles, make an electromagnet by wrapping about 100 turns of No. 22 magnet wire around a quarter-inch rod, 2 in. long. Touch the end marked *N*, Fig. 5 *a*, of the upper set of needles with one end of the magnet for one minute while the current is passing, and then with the *same* end of the magnet touch the end marked *N* of the lower set of needles for the same time and with the same amount of current. This will strongly magnetize the needles so that the corresponing ends of the two sets will have opposite polarities, and as the north-seeking end of one set is almost if not quite counterbalanced by that of the other set, the directive force of the system will be very small.

Adjust the hook so that it projects equally on each side of the split tube. Insert the lower needles in the slot in the dial and pass the fiber through the slot in the hook from the center outwards so that it will hang from the center of the rod and not from a point outside of the center. Adjust the length of the fiber until the lower needles hang exactly in the center of the coils when looking through from the side and fasten to the hook with a small drop of shellac. As it is extremely difficult to make two sets of needles that exactly neutralize each other, one set will direct the system in a north-and-south direction and the instrument should be so placed that when the needle is at rest the pointer stands exactly over zero of the scale, and the axis of the coil has an east-and-west direction. The levelling screws will enable the galvanometer to be so adjusted that the pointer lies on both zeros of the scale and the center of the mica stirrup corresponds with the center of the dial. When the pointer is at rest on the zero division, give it a slight impulse and note whether it swings to the same division on either side of zero. If not, the fibre may have a slight twist which may be removed by turning the hook one way or the other until the deflections of the pointer are equal with respect to zero.

The galvanometer should now be provided

with a glass case to protect it from dust and air currents. This case is made from five pieces of clear window glass, bound together at the edges with strips of gummed, black paper, such as is used for binding magic lantern slides and passa-partout pictures. Four small triangular blocks are glued to the base to prevent the case from slipping off. Great care should be taken to thoroughly insulate the bobbin wires where they pass through the base by making a small tube of paper to line the holes. Thoroughly coat the grooves underneath with shellac before the wires are put in and then give them a good coat. In instruments where such high resistance windings are used, small leakages of current that might occur across a moist surface or a thin layer of dust would so reduce the efficiency that proper indications will not be made. For this reason all places of probable leakage should be given good coats of shellac spirit and baked, if possible. Shellac is one of the best insulators and is easily applied.

In connecting various electrical instruments together, much annoyance is caused by the stiffness of wires of sufficient cross section to carry the current without appreciable loss. The connecting wires can be made of flexible lamp cord or several small copper wires, say No. 32 gauge, twisted together and insulated by winding tape around them. The ends should be soldered into a copper clip, as shown in Fig. 6, which is easily slipped under the head of the binding screw and insures good contact. If several of these connecting wires are made of different lengths much time will be saved during experiments in making connections.

A number of the clips may be made at once by clamping several pieces of sheet copper in a vise and working out the screw slots of all at the same time. Tin them on the inside of the bend before winding about the wire, by rubbing a hot soldering iron over the spot with rosin as a flux. Then tin the end of the wires. When the clip has been bent around the wire, squeeze it in the vise so as to make it lie close. Heat the tinned portion in a flame, when it will be firmly soldered to the wire. The tape may be secured from any electrical house for a few cents.

NOTES ON WIRELESS TELEGRAPHY.

L. T. KNIGHT.

II. Transmitting Instruments of a Wireless Telegraph Station.

The transmitting instruments of a wireless station comprises the induction coil, interrupter and primary battery, a key for sending, the Leyden jar battery, adjustable spark gap and a variable self-inductance. In general appearance the induction coil is similar to the X-ray and experimental coil, and right here at the start arises a difference of opinion as to whether the secondary shall be wound for extremely high potential or simply a normal one. There seems a preference in the German systems for coils of much less potential than the commercial X-ray coils, because a high charging power is required to charge the Leyden battery, which is continually discharging across a small spark gap. Any ordinary Rulmkorff coil will suffice for such experiments as the reader will probably care to make while following these articles; in many instances the amateur will find it to his advantage, financially, to construct the coil himself.

Referring to the last chapter, we note that the electrical "blows" were to be struck in *even* time. So with the interrupter of the spark coil, the interruptions must be steady, even and without variance. Vibrators that vary in frequency because of unreliable contacts at the make and break points, will not give the satisfaction of the higher grade vibrators, or the chemical or mercury break. It is, therefore, essential in selecting an interrupter, to choose one that is permanent and true in action.

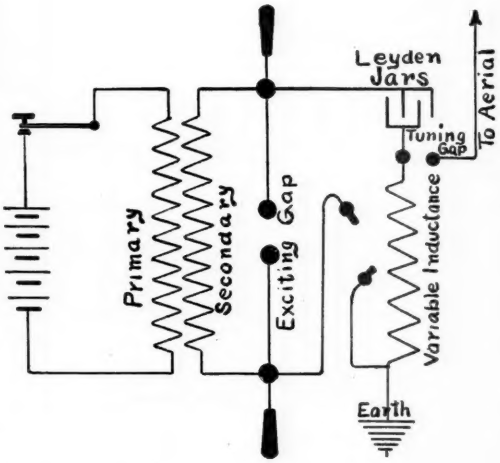
The variable inductance consists of bare wire turns about an insulated cylinder or open frame work, arranged in such shape that connections may be made with pegs, clamps or otherwise, on any part or turn of the coil as required. The

Leyden jars are connected in multiple.

In the elementary diagram here given is shown the transmitting circuit. The lower end of the inductance coil is connected to a secondary spark gap and also to the outer terminal of the Leyden jars. Two variable points or clamps affixed to flexible conducting cords are also provided. Their location is plainly shown in the diagram, and it is patent that with these two cords any portion or all of the inductance coil may be cut out, thus varying the capacity and inductance and determining the length of wave which the station will transmit.

The proper adjustment of the spark gaps having been once acquired, few changes in their position will have to be made. Generally speaking, the farther it is desired to transmit the longer the spark gap, and the stronger the current required in the primary of the induction coil. The spark, however, must be kept white and snappy, and frequent usage will make one familiar with that particular spark length and primary current which gives the most satisfactory results.

In such a transmitting circuit as is here described, the secondary charges the Leyden jar battery until the potential is high enough to jump across the spark gap. Then oscillations are set up through the Leyden jars, the induction and spark gap. As a thorough description of this part of the circuit will be necessary in explaining



the receiving circuit and the adjustment of the receiver and transmitter to meet the proper communicating conditions, further comment will be postponed until the receiving station has been dealt with in the next chapter.

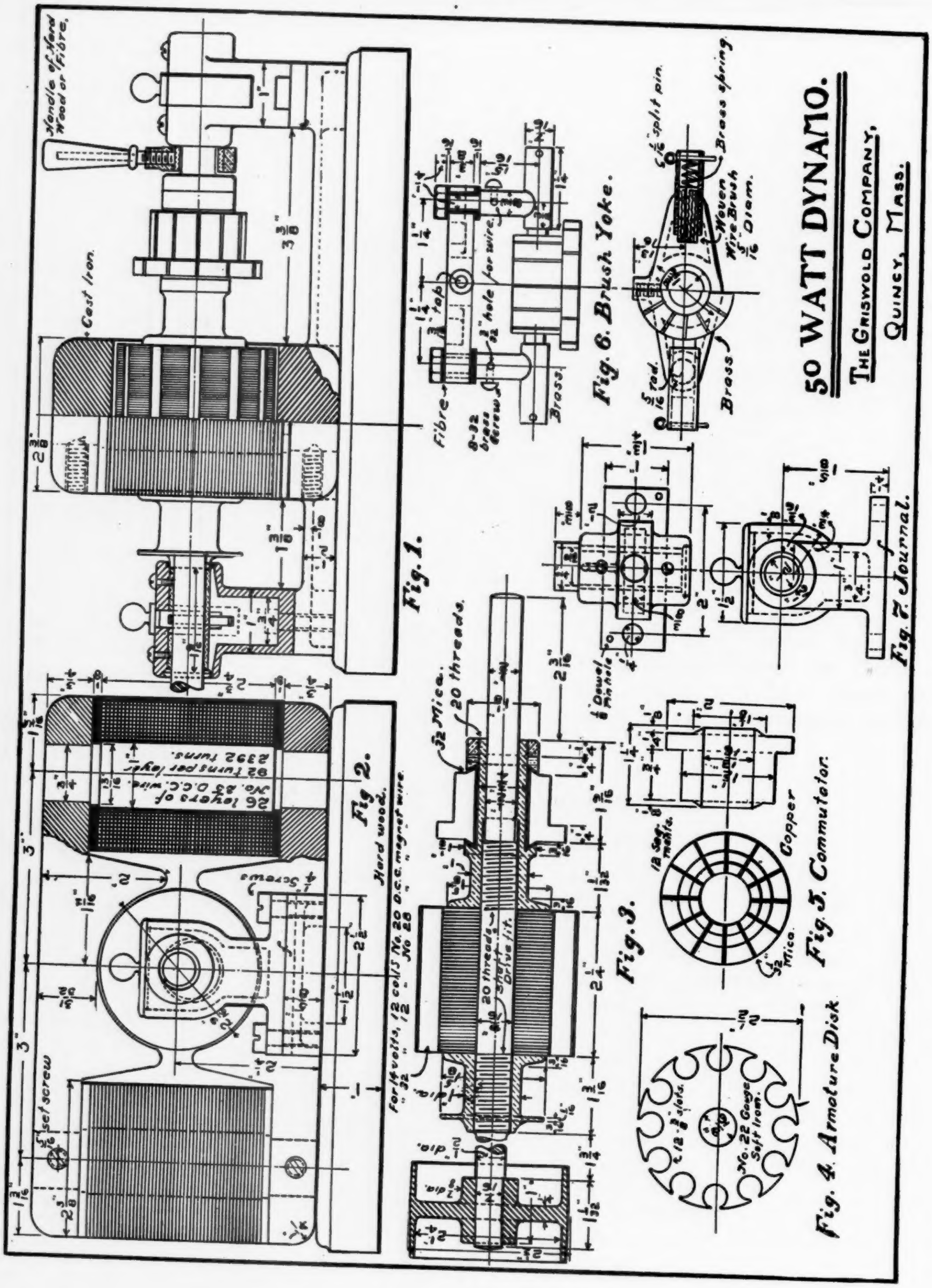
A 50-WATT DYNAMO.

R. G. GRISWOLD.

Although the majority of dynamos and motors of very recent design are of circular yoke type with radial poles, the Manchester type of field magnet has many points of merit, particularly in machines designed for amateur construction. Although there is a little more actual machine work to be done on this type of machine, it is of a character that is more easily performed than that necessary on the circular yoke type, and for this reason, more than any other, this type of machine has become such a favorite among amateurs.

Fig. 1 is a partly sectional side elevation of the field magnet frame together with the base and journal pedestals, showing the relative positions and dimensions. In Fig. 2 is shown a transverse sectional view of the field-magnet pole-pieces, mounted on the magnet cores. These magnet cores are turned from a 1 in. bar of soft wrought iron to the dimensions given, and the ends which fit into the holes in the field-magnets should be a very snug fit therein. The magnet cores are provided with flanges of $\frac{1}{8}$ in. fibre forced on, and it is well to provide a small shoulder $\frac{1}{8}$ in. deep by $\frac{1}{32}$ less in diameter than the core, against which this washer may be forced.

Fig. 3 is a sectional drawing of the assembled armature, commutator and shaft with pulley. The armature core is of the usual laminated type, the disks being $2\frac{1}{2}$ in. in diameter and of the shape shown in Fig. 4. The coil holes in the armature discs are $\frac{3}{8}$ in. in diameter and have a $\frac{3}{16}$ in. slot cut through to the periphery to facilitate the winding. The central hole is $\frac{9}{16}$ in. in diameter and is not provided with a key slot, as it is in-


50 WATT DYNAMO.
The Griswold Company,
Quincy, Mass.
Fig. 1.
Cast Iron.
Handle of Hard Wood or Fibre.
Fig. 2.
Hard wood.
26 layers of No. 23 D.C.C. wire. 92 turns per layer 2392 turns.
4 Screws
set screw
For 14 volts, 12 coils No. 20 D.C.C. magnet wire.
Fig. 3.
20 threads
Mica.
Fig. 4. Armature Disk
No. 22 Gauge Soft Iron.
12 Segments.
Copper
Fig. 5. Commutator.
Fig. 6. Brush Yoke.
Fibre
Brass
Woven Wire Brush
Brass spring
split pin
Fig. 7. Journal.

tended that these disks should be forced on the shaft, which is made a tight fit in the hole. With every one of the disks thus pinching the shaft, there is little danger of the torque twisting the armature on its shaft.

The disks are clamped between two flanged collars, the flanged portion being $1\frac{5}{8}$ in. in diameter and being well rounded as shown. The shaft is provided with threads as shown, onto which these collars are screwed, hard up against the disks, firmly pressing them together. If greater security is desired a $\frac{1}{8}$ in. hole may be drilled through from end to end every 120° and bolts passed through these holes provided with nuts let into counterbores, but this is hardly necessary on so small a machine. The flange on the outer end of one of the collars is provided to prevent any oil finding its way to the armature by creeping over from the bearing. The magnetic portion of the armature is $2\frac{1}{4}$ in. long. The pulley, owing to its small diameter, is cast with a solid central web instead of spokes.

The commutator is of a design familiar to those acquainted with dynamo construction, the segments being bevelled at each end to fit under the bevelled groove in the collars. The clamping collar at the front end of the commutator fits smoothly over the core, but is not threaded; it is forced into place by an auxiliary nut on the core back of it. A layer of fibre or mica is laid between the segments and collars, that between the bevelled ends and the collars being in the form of a washer. Fig 5. is a front view of the commutator which is $1\frac{1}{4}$ in. in diameter. These lugs are $\frac{5}{16}$ in thick axially.

The brush holder, Fig. 7, is of the adjustable type and carries two brushes of either woven copper wire or carbon, which act in a radial direction against the commutator. They may be easily shifted while the machine is in motion and clamped in position by the small handle which terminates in a $\frac{3}{16}$ in. screw. The brush clamps need no special description as the detail drawing gives all dimensions. The actuating springs are made of No. 26 spring brass wire (B. & S.) and inserted behind the brushes, being held in place by the split pins shown. These springs feed the brushes to the commutator as they wear.

The journals shown in Fig, 7, and also in Fig 1., are of the self oiling type, having oil rings 1 in. in diameter outside and $\frac{13}{16}$ in. in diameter inside, by $\frac{1}{4}$ in. wide. These rings dip into the oil well below the shaft and keep the bearing well oiled by revolving with the shaft. The brass bushings are held in place by two 8-32 machine screws put through from the top.

This machine can be built in either of two windings; one for 14 volts and 3 amperes, and the other for 32 volts and $1\frac{1}{2}$ amperes. The 14 volt winding consists of 12 coils of No. 20 double cotton-covered magnet wire, each coil containing 22 turns of wire. The armature winding for 32 volts consists of 12 coils of No. 28 wire, each coil containing 54 turns of wire.

Each field coil contains 56 layers of No. 25 double cotton-covered wire, each layer containing 92 turns, so that there are 2,392 turns of wire in each coil. The two field coils are connected in multiple when used in connection with the 14 volt armature winding, and in series when used with the 32 volt winding, the fields being connected in shunt with the armature. The speed of the machine for 14 volts is 2,400 revolutions per minute; for 32 volts it can be run slightly slower than this.

The machine work on this dynamo is of the simplest possible consistent with practical results, and all of the fitting except the brush holder is plain lathe work.

The English newspapers report a new application in Australia of the principle of the coin-in-the-slot machine, stating that if a stamp cannot be purchased conveniently it will be possible in the future to drop a letter into the orifice of a postal box and a penny into a second orifice, and the words "one penny paid" will be found impressed on the envelope when the box is opened by the post-office authorities, thereby securing the transmission of the letter.

The Grand Trunk Railway Company will substitute electricity for steam in the Sarnia tunnel, and will install a plant for that purpose to cost $500,000. The third-rail system will be used.

An excellent lubricant for drills and metal cutting tools in general can be made by mixing turpentine with machine or lard oil in equal proportions. The turpentine causes the tool to cut very keenly.

TELEPHONE CIRCUITS AND WIRING.

ARTHUR H. BELL.

VI. Central Station Systems.

Believing that amateurs who have followed this series of articles, and have made experiments in connection with them, would like to become familiar with the rudiments of practical telephony and continue, step by step, to the higher branches of the art, the writer will describe some of the simple apparatus and connections common to the many systems.

When the drop falls the operator places a "plug," connected with the operator's instrument, in the "jack" and talks with the party calling.

Fig. 2 illustrates a plug and a jack. The plug is, for convenience, built of round brass rod, so that it requires no particular position when entering the jack. Earlier styles of plugs were constructed of two flat strips insulated with hard wood or rubber, but these are now seldom used except in telegraph circuits.

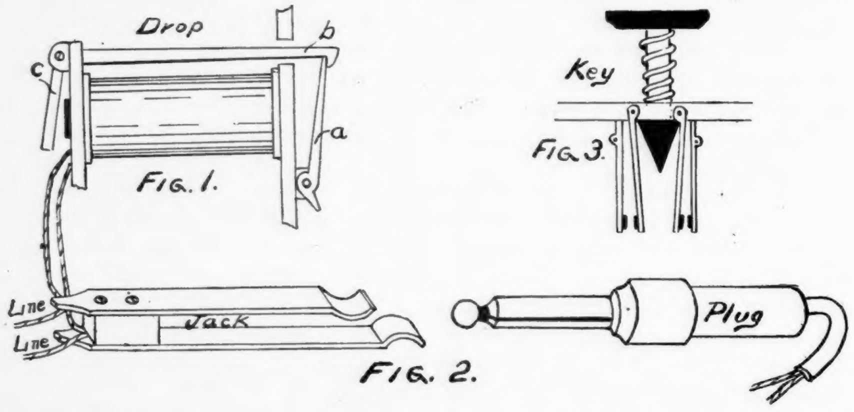


FIG. 2.

It is the custom, in certain types of exchanges, to signal the central office by turning the crank of the magneto generator of your instrument. The current generated passes over the line wire to the central switchboard, where it energizes an electro magnet device called a "drop". There are several styles and shapes of drops, but the fundamental principal is that of the electro magnet, wound with very fine wire to a resistance of 500 or more ohms, as the requirements may be.

Fig. 1 illustrates a drop. The shutter *a* is locked in place by the trigger or tongue *b*, which is part of the armature *c*. When the magnet becomes energized the armature, which nominally is a small fraction of an inch from the core, and consequently the tongue attached to it is moved upward an eighth of an inch or so. The shutter is inclined somewhat outward and drops when released by the action of the armature.

It will be seen that when the plug, with its conductiug pair of flexible wires, is inserted in the jack, which likewise has connection to a pair of wires, that whatever may be electrically connected on the plug side is given connection with whatever may be affixed to the jack wires, and the means of connecting or disconnecting is controlled by the hand that manipulates the plug. And if there were two distinct lines, each ending in a jack, and a cord bearing a plug at each end was inserted the two jacked lines would be given metallic connection with each other through the plugs and flexible cords. Flexible cords are made of tinsel, like electric light cord, for example, and electrically are equal in conductivity to solid wire which, of course, could not be utilized for the purpose.

If we were to devise an experimental central office for the purpose of studying the early principles of switchboards, we would require a special plug and cord attached to the central operating instrument, with which calls would be answered. The plug would then be removed and the subscriber conneted with the line called for by the double plug and cord device. Such an arrangement would not suffice in actual telephony at the present time, yet such was the method used up to the day the "key" was introduced, a score or more years ago. A key is a switching device, and its purposes are many. Fig. 3 illustrates a key adaptable to the foregoing circuits. By pressing down the button the rubber plunger is forced against the two inside springs, to which are affixed wires leading from the telephone used by the operator. To the outside springs are connected the plugs and cord device mentioned in the last paragraph. Further pressure on the plunger forces the inside springs against the outer, and places the operator's telephone in direct communication with the station jacks in which she may insert the plug or plugs. When pressure is removed from the key the operators' set is removed from the cord circuit.

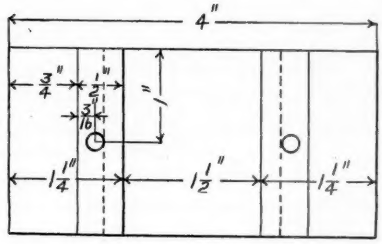
PATTERN MAKING FOR AMATEURS.

F. W. PUTNAM.

IX. A Hollow Tray. — Using Loose Pieces With Pattern.

The next pattern to be described is for a hollow tray. Large trays of the same style are frequently used on machines for holding tools and are then known as tool trays. Fig. 55 shows the pattern which is to be made with a vertical core. It will be noticed that the tray is hollow or recessed; the green sand core which forms this, projecting downwards from the cope.

The hub *A*, Fig. 55, is turned, together with the core prints, from one block of wood, as shown in Fig. 56. The plate, or bottom of the tray, is made from a piece of wood $\frac{3}{16}$ in. thick, as shown in Fig. 57. A hole $\frac{3}{4}$ in. in diameter is bored through the center of this plate to receive the



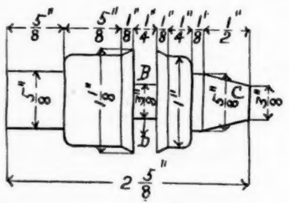
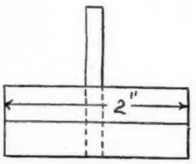


Fig. 56.



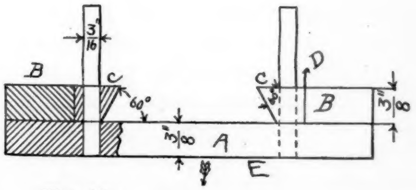


Fig. 60.

two parts of the hub, which are made with shoulders $\frac{3}{4}$ in. in diameter to fit this hole. The shoulder is clearly shown at *B*, Fig. 56, the block, after being turned, being cut in two pieces at *D* with a back saw. The sides of the tray are shown in Fig. 58.

It will be noticed that the sides are bevelled $\frac{1}{16}$ in. to allow the green sand core to be removed easily from the mold. These pieces are so small that care must be taken in planing them. It will probably be found advisable to use two pieces of stock about 8 in. long, each piece being later cut

up for one long and one short side. These sides are to be glued and nailed to the plate, or base piece. The corners are mitred; the ends of the side pieces being, of course, cut off at 45°. The two parts of the hub are fastened to the plate sim-

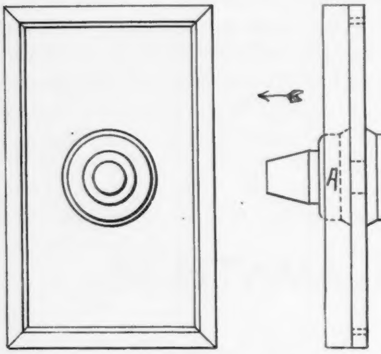


Fig. 55.

ply with glue. This will prove amply sufficient, if the shouldered ends fit tightly in the center of the plate.

Fig. 55 should be carefully studied before the hubs are glued together. The tapered part of the core print *C*, Fig. 56, is to come on the top side of the plate, as shown in Fig. 55. The arrow in Fig. 55 shows the direction in which the pattern is to be withdrawn from the sand. This draft should not be made until the sides have been final-

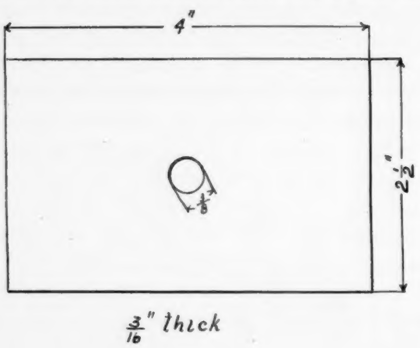


Fig. 57.

ly fastened to the plate. The hub and bottom core print being round, may be made without draft, if they are sand-papered to a very smooth surface, but care must be taken that there is no back draft at these points.

The next pattern brings in a new principle; that of using loose pieces with the pattern. Fig. 59 shows the casting of a small V way, as it is called. These V ways are in very common use on machines. Sometimes the tail stock of a wood turning lathe or machine lathe has a V way for a base piece, being similar to the one shown in Fig. 59. This V way slides along a dove-tailed track and has the advantage over the ordinary tail stock of never raising from the shears.

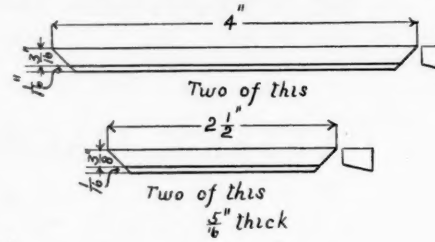


Fig. 58.

Fig. 60 shows three views of the pattern for this casting. The pattern is made up of seven parts; *A*, Fig, 60, is the base piece; *B* is the end piece, which is fastened to the top surface of *A*; *C* is the loose piece, made separate from the rest of the pattern, and used to form an angle of 60° with the top surface of the base. The stock

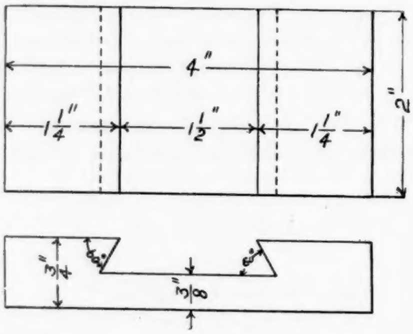


Fig. 59.

should be taken wide enough to make both *B* and *C*, and should be planed to the required thickness, $\frac{3}{8}$ in. The bevel of 60° is planed on one edge and carefully tested with the T-bevel.

The block which should be long enough to make both sets of pieces, *B* and *C*; *B* can then be readily planed to the required width, $\frac{3}{4}$ in. The edge of the piece *C*, left rough by the saw cut,

must also be planed so as to leave the stock $\frac{1}{2}$ in. in width. Having sharpened the planer blade, next clamp *C* in the vise very carefully so as not to crush the block and plane down this rough edge. If a good vise with a perfectly smooth jaw is not available the piece *C* may be drawn over the bottom surface of the plane by hand. *C* must fit tightly against *B*, so that a close joint may be made at *D*, Fig. 60. These loose pieces are necessary because the parts *C*, Fig. 60, overhang, so that the pattern cannot be removed from the sand in any direction. In cases like this the overhanging parts are fastened loosely to the main part of the pattern by wires or wooden pins.

After the pattern has been rammed up in the nowell, the base part *A*, Fig 60, is moved in the direction of the arrow, the parts *C* being still left in their positions in the sand. These are next carefully moved towards the center of the opening and lifted out. It is evident that the loose pieces must be easily separated from the main body of the pattern and should, therefore, be fastened by pins, so that they can be readily removed.

Fig. 60 shows the holes that are to be bored to receive the wood pins. These pins are $\frac{3}{16}$ in. in diameter. They may be made slightly smaller, but if this is done care must be taken that the pins do not twist off when the pattern is molded. No draft should be made on the pattern until all parts are complete. Instead of tapering the loose pieces slightly for draft, they may be squared off $\frac{3}{64}$ in. less in length than the width of the base piece.

A SIDEBOARD.

JOHN F. ADAMS.

While the illustration of the sideboard here shown may give one the impression that it is a very plain piece of furniture, it will be found by anyone making it that the design and general appearance will be quite satisfactory. Of course the wood, quartered oak, should be carefully selected, all joints well made, and the staining so done that the markings of the grain will be brought out to the best advantage.

The framework for the top, containing the mirror, 40 x 16 in., is made separately from the under or cabinet part. A wooden panel may also be substituted for the mirror, but as the mirror adds much to the appearance, this is not recommended.

For the corner posts four pieces $40\frac{1}{2}$ in. long and $1\frac{3}{4}$ in. square are required. Mortises are cut for the cross pieces of the end panels, the lower ones being located to bring the under edge of the cross piece $7\frac{1}{2}$ in. from the floor and the top edge of the upper ones flush with the top. The mortises are 3 in. long, $\frac{1}{2}$ in. wide and 1 in. deep, and cut to bring the outer edges $\frac{1}{2}$ in. from the outer edges of the posts. Grooves $\frac{1}{4}$ in. wide and deep are cut for the edges of the panels, which are made of stock $\frac{1}{4}$ in. thick and with their outer sides $\frac{1}{2}$ in. from the outer edges of the posts. The cross pieces are $21\frac{1}{2}$ in. long and $\frac{7}{8}$ in. thick; the upper ones $5\frac{1}{2}$ in. wide, and the lower ones $4\frac{1}{2}$ in. wide, these lengths allowing $\frac{7}{8}$ in. on each end for tenons. Grooves are cut for the ends of the panels. The lines for the mortises and grooves should be laid out with a marking gauge to ensure close fitting joints. The panels are 23 in. long, $19\frac{1}{2}$ in. wide and $\frac{1}{4}$ in. thick, these dimensions giving a slight allowance for trimming.

The cross piece under the silver closet is $33\frac{3}{4}$ in. long, 3 in. wide at the ends, 2 in. wide at the narrow part, and $\frac{7}{8}$ in. thick. The wider ends may be secured by gluing on short pieces curved on the inner ends, as shown. Frames are made of $\frac{7}{8}$ in. stock to go between the silver closet and lower drawer, between the two drawers and above the upper drawer, those under the drawers having an oak front piece and forming the runs for the drawers. These frames should have mortise and tenon joints and be fitted around the posts, sawing into the latter a little to take the corners of the frames, thus adding stiffness to the construction. The floor of the silver closet is made by gluing up two $\frac{3}{4}$ in. brads, the upper sides of which should be flush with the top edge of the cross piece, and the inner edge set in $\frac{1}{2}$ in. to allow space for the back panelling. A similar allowance for the

back panelling should be made with the frames above mentioned.

The top is 48 in. long, 24 in. wide and $\frac{7}{8}$ in. wide and $\frac{7}{8}$ in. thick owing to the width; it will have to be glued up from two pieces. Care should be taken to secure a good match on the grain and color of stock used. A neat moulding is run around the under side, as shown. It is fastened by screws put up through the upper frame. The two small drawers are 20 in. long, $4\frac{1}{2}$ in. deep and 21 in. from front to back. A division piece $\frac{7}{8}$ in. thick is placed between the two upper frames and nailed in plaee before putting on the top.

The large drawer is 41 in. long, $7\frac{1}{2}$ in. deep and and 22 in. wide. Strips will have to be placed on the frames, at the outer edges of the drawers to keep the latter in place when being pushed in.

The two doors are $15\frac{1}{2}$ in. high and $20\frac{1}{2}$ in. wide, the stiles and rails being made of $\frac{7}{8}$ in. stock, $2\frac{1}{2}$ in. wide, with a $\frac{1}{4}$ in. groove for the panel. The panels are 16 x 14 x $\frac{1}{4}$ in., with V markings $2\frac{1}{2}$ in. apart to represent matched strips, or matched stock $2\frac{1}{2}$ in. wide may be used. In hanging the doors, they should be set in about $\frac{1}{4}$ in., a stop block being glued to the bottom of the closet to hold the inner ends at the right place. The usual catches and knobs are added. A thin strip is is placed on the door at the right, to cover the crack.

The framework for the top part requires two front corner posts 23 in. long, and two back ones 29 in. long, all being $1\frac{3}{4}$ in. square. The two cross pieces at each end are 2 in. wide, $1\frac{1}{4}$ in. thick and 22 in. long, allowing for $\frac{7}{8}$ in. on each end for tenons. The lower cross pieces are 2 in. above the top of the cabinet, and the upper ones $1\frac{1}{2}$ in. below the top of posts. The corner posts of the top part should fit exactly over those of the lower part, and are attached thereto by $\frac{1}{2}$ in. dowels, the holes for same being bored in the top board of the cabinet when the top part is completed. The tops of the posts are bevelled slightly. The shelf over the mirror is $43\frac{1}{2}$ in. long, $19\frac{3}{4}$ in. wide at the ends, and cut in with an easy curve to 12 in. wide. The frame for the mirror is made with mitred corners, the top and bottom pieces being 2 in. wide and the end pieces $11\frac{1}{4}$ in. wide. A rabbet $\frac{1}{4}$ in. square is cut for the mirror, the latter being well protected at the back, first by a layer of thick paper and then back with well fitted picture backing. The board at the back of the shelf is 5 in. wide, $\frac{3}{4}$ in. thick and 42 in. long, allowing $\frac{1}{2}$ in. at each end to fit into grooves cut in the corner posts. A plate guard 1 in. wide, $\frac{1}{2}$ in. thick and 45 in. long is placed at the top, as shown. The detail of making the drawers, and some other minor matters is not given here, as such work has been quite fully covered in previous articles.

The most effectual means for the removal of bolts that have rusted in, without breaking them, is the liberal application of petroleum. Care must be taken that the petroleum shall reach the rusted parts, and some time must be allowed to give it a chance to penetrate beneath and soften the layer of rust before the attempt to remove the bolt is made. Bolts and studs on which the nuts are fixed with rust are often broken off through impatience. In most cases a small funnel built round a stud or bolt end on the nut with a little clay and partly filled with any of the searching petroleum oils, and left for a few hours, will enable the bolt or nut to be moved.

HOW TO MAKE PHOTO' TRAYS.

W. S. STANDIFORD.

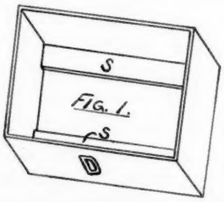
The amateur photographer, at the beginning of his experience with the camera, usually has an idea that a costly outfit of trays for developing, toning and fixing, is necessary for the making of good pictures. Now nothing could be further from the truth, as cheap but excellent trays can be made by any person who can handle the few tools needed for their construction.

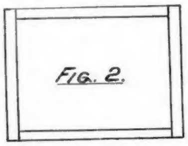
The writer of this article is an amateur of years experience, and knows that many prospective amateurs are deterred from purchasing a camera on account of the expense of the outfit, as they naturally do not care to put much money in their first camera and photographic material—not knowing whether they will like the work.

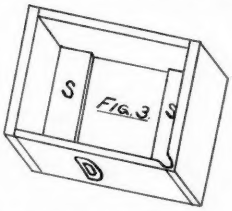
To the prospective amateur photographer the writer would, therefore, recommend the following trays as being extremely handy, easy to make and cheap, they being able to stand considerable rough usage. The lighter pasteboard dishes could be made of sufficient lengths and diameters, to fit one within the other, thus occupying small space, and also being light in weight for traveling. We will first make a tray out of a cardboard box that contained two dozen sheets of writing paper and the same amount of envelopes. Both bottom and cover can be used, thus making two dishes—one for developing and the other for fixing.

The average size of a box containing letter paper is $5\frac{1}{4}$ in. wide, $6\frac{3}{4}$ in. long and $1\frac{1}{4}$ in. deep. Take the lid off a cigar box, cut two pieces one-quarter of an inch wide an $6\frac{3}{4}$ in. long, and glue them lengthwise in the pasteboard box—each strip being one inch from the sides. After this is dry paint the inside and outside with asphaltum varnish and let dry.

Take a piece of white paper 1 in. square, and with pen and ink mark the letter "D", pasting the paper on the side of the box. Buy one-half pound of paraffine and one-half pound of beeswax at a total cost of 30 cents. Melt both in an old tin tomato can or dish, pour it into the tray so as to make the wax flow over the bottom and up the sides, getting it as near the top as possible. Then take a brush dipped in the melted wax and finish waxing the inside, sides and bottom. When cold it is ready for use, being unaffected by the usual acids and alkalies in the developing, fixing and toning baths used in photography. Fig. 1 shows the tray as finished, the strips *S S* being used to keep the plate from sticking to the bottom; they also strengthen the tray. The letter *D* on the side shows that the tray is to be used for developing. The letter paper box of the indicated size makes a most admirable dish for 4 x 5 negatives and smaller, being compact and light. Of course various sizes of cardboard boxes could be used to make trays suitable for different sizes of negatives.







There should be no difficulty in getting suitable boxes of heavy cardboard, as most all of the large dry goods stores are, generally speaking, only too glad to get rid of them. When a larger box is to be made into a tray, should the sides be higher than desired, they can be cut down—first marking with a pencil a line on the side of box, line to be of equal distance measured from the bottom, and then cutting with a knife or scissors along the line.

We will now take up the construction of wooden trays which, although heavier than pasteboard, are more durable. They are also far superior to the hard rubber and fibre goods sold in the

stores, which are very brittle and have to be handled carefully lest a piece should be broken out. From this fault the thin flexible rubber trays made in small sizes up to 4 or 5 inches are excepted, it being very difficult to break them.

To make a good developing dish of wood proceed as follows; Suppose it is desired to make a 5 x 7 in. tray. The first article needed is the wood, which we get by making a raid on the cellar of our grocer, or some cigar dealer. The dealer generally has a fine collection of boxes with thin boards and is found willing to give away a few of them. Selecting boards about ¼ or ⅜ in. thick and 5 or 8 in. wide, free from knots, smooth them off with a plane or if one is not handy, take a piece of coarse sandpaper and tack it around a block of wood and smooth the piece with that. After the roughness is taken off, two strips 1¼ in. wide, ¼ in. thick and 5¾ in. long are made. Also cut two more strips of wood the same thickness and width, and 8 in. long.

Now take the two 8 in. strips, one of the 5¾ in. strips, fasten the latter across the top of the longer pieces, one on each end, by the aid of wire brads; then nail the other strip across the other end. You then have a frame shaped like Fig. 2. Next we cut a piece for the bottom of the tray, 8½ in. long and 5¾ in. wide; if a board of the correct width is not at hand use two narrow pieces of sufficient width to be level with side of dish when the bottom is nailed on with the ¾ in. brads, spacing about ½ in. apart.

Take your knife and cut in one corner on the inside of tray, diagonal to the sides, a lip for pouring out the solution. Cut two narrow strips ¼ in, wide and 5¼ in. long out of a cigar box lid and glue them on the bottom at a right angle to the sides, each strip being placed 1½ in from the end of tray. Carpenter work finished, we next proceed to mark the letter "D" on a piece of paper one inch square, and then glue it on the side. Also glue a heavy piece of writing paper across the joint, if two boards have been used instead of one.

Coat the top, bottom and sides with asphaltum varnish; when dry, coat with the mixture of paraffine and beeswax in the manner previously described. Fig. 3 shows the finished tray. The construction of various sizes of wooden dishes for developing, toning and fixing baths can be designed by the amateur photographer to suit his needs by following the above methods of procedure.

These articles, if carefully made, will last many years and give good satisfaction. A fixing tray should be made to hold six to twelve negatives. Those living in tropical climates will find it best to use the following composition to coat the trays with instead of using the wax: Put litharge, finely powdered, into glycerine to make a semi-liquid paste. Mix the two thoroughly and pour into the bottom of dish, levelling it with a piece of pasteboard bent into L shape. Grease the piece with oil or vaseline to prevent it from sticking. This cement will be found to be waterproof. Mix the ingredients as needed, as it hardens very rapidly. When the bottom is hard coat the sides in the same way. When the cement is thoroughly dry give it a couple of coats of asphaltum varnish. After that has set wash the tray well, putting in a pinch of washing soda with the first wash water to cut the grease. It is not necessary to put the cement on the outside, the varnish being sufficient to keep it from rotting.

At a recent meeting of the Academy of Science of France, held at Paris, M. Henri Moissan presented a paper concerning the preparation and characteristics of a new carbon compound containing molybdenum. This compound is obtained by heating charcoal with melted molybdenum and aluminum in an electric furnace. The resultant metallic mass is treated with a concentrated solution of potash, and needles of well-defined crystals of the new carbon compound are obtained.

The substance is very hard, is hardly attacked by acids other than nitric and is not decomposed by water or steam at a temperature below 600° C. It resembles the carburet of tungsten, already known, which is not considered surprising, as the metals tungsten and molybendum are much alike. It is thought that this new compound may play a role in molybdenum steels.

The method of preparation shows that even at a rather high temperature (that of boiling aluminum) a molybdenum compound is obtained which contains twice as much carbon as the compounds formed at the highest heat obtainable in an electric furnace.

Osmon, a new fuel, is made from peat. The peat used contains 90 per cent of water, of which 20 to 25 per cent is removed by means of an electric current. The peat is then further dried and passed through a machine which breaks it up and forms it into briquettes, or nut shaped pieces.

AMATEUR WORK.

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NOVEMBER, 1904.

The increase in Manual Training instruction is very encouraging in some sections of this country, while in others such instruction is sadly neglected. Those who are familiar with the practical benefits to be derived from manual training, when accompanied by a proper equipment and under the direction of skilled instructors, know that it has, in the few years during which it has formed a part of the school curriculum of our largest cities, more than demonstrated its value, and that those places which do not provide such instruction are not properly serving the educational requirements of their communities. The greater expense required for the equipment for such instruction is undoubtedly responsible for its lack in many places, but undue economy in this line causes a direct loss to a very considerable portion of the school attending population. How great this loss is cannot be realized by those who have not given the subject proper investigation, but that it is great will be admitted by any one at all familiar with the subject. Our object in mentioning the lack of such instructian is to encourage the study of its great practical value as a part of the educational system of the country, with the hope that every community in which there is a sufficient number of pupils to warrant such instruction, will cause strong and continued efforts to be made until it is secured. In furtherance of this idea we shall be pleased to advise any of our readers who may desire information upon the subject.

BOOKS RECEIVED.

Care and Handling of Electric Plants. Norman H. Schneider. Spon & Chamberlain, New York. $6\frac{1}{2} \times 4\frac{1}{2}$ in. 100 pp. Flexible leather leather covers, $1.00.

This manual is intended as a handbook of practical information for those who are called upon to operate a commercial or military electric plant without having had previous experience, while it will also be found to contain much of value to the engineer. It is written with the aid of notes actually obtained in handling the apparatus described, the chapter on incandescent lamps being especially notable, as this chapter has not been given in other works the prominence it deserves. In the selection and composition of the tables the author has endeavored to make them applicable to both American and foreign practice. The text is very fully illustrated, making the manual of exceptional value. The book is strongly commended to those desiring information on this subject.

The How and Why of Electricity. Charles Tripler Childs. Electrical Review Publishing Co., New York. $7\frac{1}{2} \times 5$ in. 127 pp. Cloth, $1.00.

While there are many books treating of electricity, there is still room for this one. The various phases of the subject are treated in a plain yet very readable manner. While each chapter is necessarily short, because of the size of the volume, the general principles and application are set forth in a readable way, and to those desiring to read up on the subject, without making an extended study, this book will be found very serviceable.

Photography in Advertising, Figure Composition, Home Portraiture. Nos. 63, 64, 65. Photo-Miniature. Tennant & Ward, New York. 25 cents each.

The high standing of contributors writing these manuals in this series of booklets has long ago given them a prominent place in the literature appertaining to photography. The mention of the particular subject covered in each number is all that is now required to assure the purchaser that it is one in which he may be interested and will find of value.

A GASOLENE TOURING CAR.

R. G. GRISWOLD.

I. The Gear Case.

The design of a car printed in the September issue is, in many respects, very difficult for the amateur, if not almost prohibitive. There are many parts that could hardly be handled by the amateur of limited facilities, while in other respects there are many features that could be vastly improved. A car like the one to be described in the following series of articles can easily be constructed in five or six months by a man or boy of ordinary mechanical skill, as the entire car has been redesigned to meet the needs of amateur builders that are not fortunate enough to possess an *entree* to a well equipped machine shop.

This car, as here illustrated is of the popular detachable tonneau type that can easily be changed to a runabout in a few minutes. It will carry five persons with comfort, while seven can be accommodated by using corner seats in the front of the tonneau. The body is built on very graceful lines, and while it is extremely roomy, it is not at all difficult to build, provided the directions are closely followed. The painting and trimming will be taken up in due course.

This machine has proven itself extremely satisfactory in every respect, and has ample power to climb any ordinary grade on the high or intermediate gear, while on the low gear it has an abundance of power to negotiate very steep hills. It is easily handled and is geared for the following speeds when the engine is turning 1,000 revolutions per minute; twenty-five miles per hour in full gear, twelve and one-half miles on the intermediate, and four miles on both the low speed and reverse.

In general the car is of the latest accepted practice, a double opposed cylinder engine being placed under the hood in front, coupled to the driving shaft by a positive acting expanding clutch, which runs in oil and works metal to metal. The change speed gears, which give the changes mentioned above run in oil in an oil-tight gear case. The greater part of the machine work can be performed on an eleven inch foot-power lathe and bench drill capable of taking a half-inch drill. The operations requiring outside work are very few and inexpensive.

One of the greatest advantages of this design is that castings and forgings of almost every part detailed and described may be readily obtained at a lower cost than the amateur could afford to build the patterns for and have them cast. These castings have been made as nearly to size as possible in order that the machine work on them may be reduced to a minimum, and the fact that so little work is necessary greatly enhances their value.

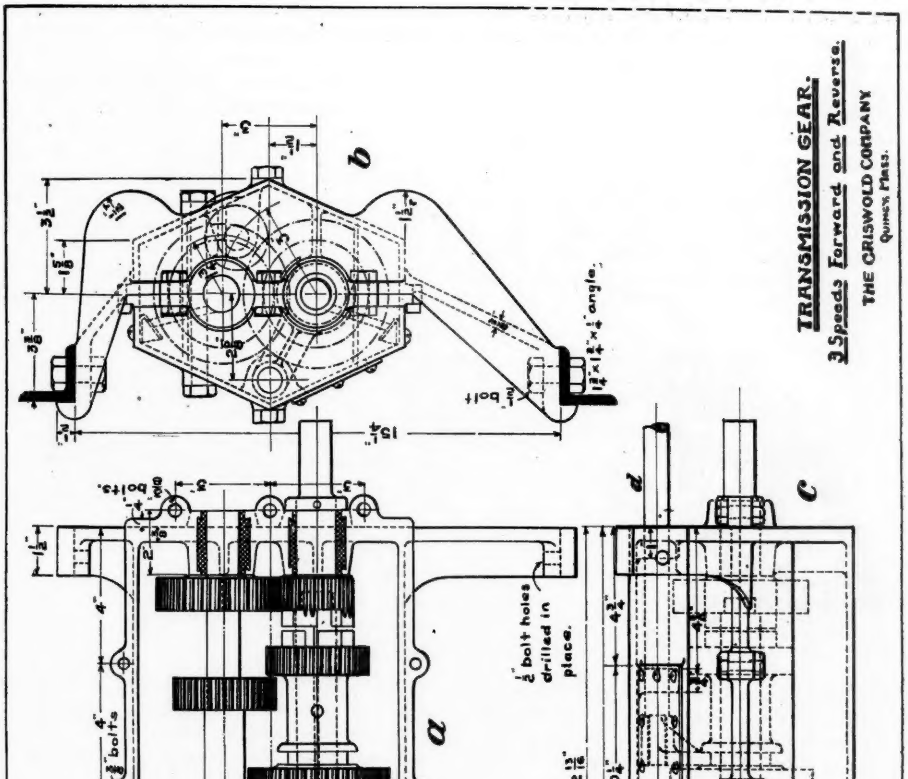
It has been thought best to begin with a description of the various details of the car, taking up the hardest and most tedious work first, and gradually building up to the finished car. An advantage of this system is that the working room of the builder is not taken up by the body of the car while the small parts are being made, and when the running gear and body of the car are in process of construction these parts may be incorporated in their proper places. Owing to the lack of space the full design cannot be given in this issue.

Perhaps the gear case will be as good a part to commence on as any. This transmission is the popular sliding spur-gear type, three speeds forward and reverse. There are no driving spurs in mesh on the high speed, and the bevel gears are absolutely necessary in any type of car where the power is transmitted from a longitudinal shaft to a transverse driving axle. This change must be made either in the gear case or in the differential on the rear axle, as in the propeller drive. This is one great fault with the gear shown in the September issue. It is impossible to drive the car without transmitting the power through two sets of gears on high speed, where the effort should be transmitted as directly as possible. When spur gears are driven at a high rate of speed they make a good deal of noise unless they are very well fitted, and the wear soon gives clearance between the teeth. Bevel gears are not so apt to do this.

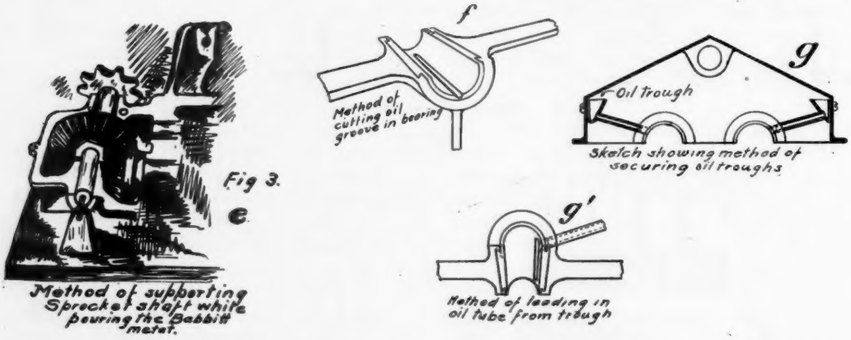
As stated before, the gear shown in Fig. 2 is designed particularly to meet the needs of those unable to command a large machine shop where the planing of the two halves is generally done, as well as the boring for the shaft bearings. It is as light as is consistent with the duty required of it, while the gears and shafting are made unusually stiff and strong to obviate as far as possible excessive wear.

The upper half, or cover, Fig. 2 *a*, is provided with a cored hand-hole through which examination of the gears may be made without removing the gear case from its position in the car. This opening is closed wish a brass plate *b* 1-16 in. thick, secured by 8-32 round-head brass machine screws spaced about every two inches, a gasket of heavy cotton cloth or thick manila paper being placed in the joint, to render it oil-tight. The surface of the slightly raised edge around this hole can be easily dressed to a good surface with a file.

The joint between the two halves of the case, which is usually planed to a true surface, can be readily made with a large file in the following manner. The


TRANSMISSION GEAR.
3 Speeds Forward and Reverse.
THE GRISWOLD COMPANY
Quincy, Mass.
Case of Cast Iron.
Length over case, 22 13/16
1/2 bolt holes drilled in place.
a
b
c
d
e

castings have been given very little finish at the adjoining surface to reduce the work of fitting. Of course the best job can be done by planing or milling, but a very satisfactory fit can be made by hand. Fasten the upper half to some firm bench by means of the little feet cast on the case, and with a large, sharp file work the surface down until a straight edge touches at every point on either side and ends. A fourteen inch file is about the size to use so that it will reach across from side to side. As to the accuracy of the joint, this may be tested by planing up a plank of hard wood 28 x9x2 in., so that a practically true plane results. Then, by laying this improvised surface plate on the work, any high or uneven places may readily be detected.



When the upper half is finished the joint surface of the lower half is finished in exactly the same manner. Then the finished surface of the top half is given a very thin coat of red lead in oil, and any excess rubbed off with the finger. The two pieces are then laid together in position and the upper piece given a *very slight* movement to and fro. This action will mark the high spots or points of contact on the lower piece, which are then dressed down with a smooth file when the cover is removed. This process is repeated until a perfect bearing is obtained.

The holes for the various bolts are then laid off on the finished surface of the upper half and drilled from the inside, with the piece resting on its feet. This half is then used as a jig and is laid down on the bottom half, clamped firmly in place and the holes in the lower half drilled by running the drill through the holes in the top. This insures that all holes will be exactly in line and match. The bearing for the nuts should be faced so that the nut will have a good seating. The holes for the bolts securing the case to the frame may also be drilled at this time.

The hole for the gear shifting rod *d* in the upper half is drilled with a ⅜ in. drill, either from the inside, using a small ratchet, or from the outside on the drill press.

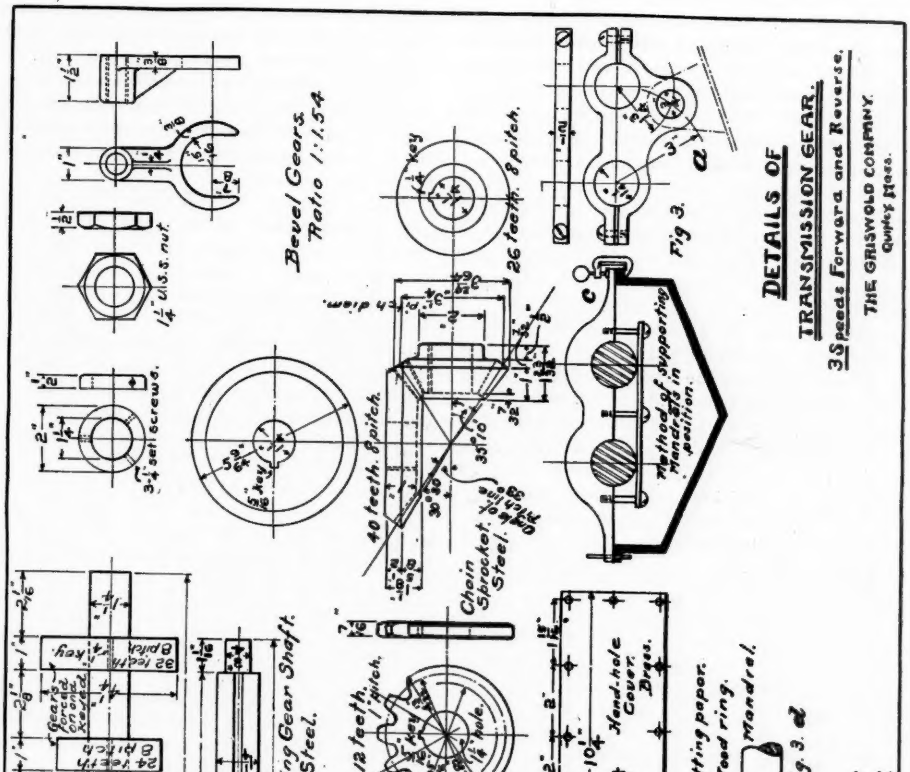
On the lower half the same directions apply as to the ½ in. hole for the reverse pinion shaft. If drilled on a press a hole should be laid off and drilled in the front of the case to admit a ½ in. round bar of steel flattened on the end and ground as a flat drill. When this method is used it is well to wait until the shafts or mandrels are in place and then use the small jig shown in Fig. 3 c. The holes in this jig are bored exactly to size, with their location carefully laid off, the piece split, as shown, with a saw, and the screws fitted to clamp the mandrels firmly. Then when the mandrels are babbited in place, this jig is clamped to them so that the drill guiding hole comes before the projection *e* in the lower half of the case. This forms a guide which controlls the action of the drill and insures that the pitch lines of the reverse pinion and meshing gears are exactly in contact.

The case is now ready for the bearings. These are made of Babbitt metal, which is the best metal that can be used in this place, especially since the bearings are subjected to very hard duty. They remain very cool under load and do not grip when heated, as do brass bushings. They have a comparatively long life and are readily replaced by the owner of the machine when badly worn by chipping out the old metal, relining the shafts and again pouring in new metal.

Chip and clean the recesses cast in the case so that the metal may have a good hold. Prepare two mandrels about 1½ in. longer than the bearings from the extreme end of the outside to the opposite extreme end of the inner ones and 1¼ and 1½ in. in diameter, respectively. Polish the bearing portions as smoothly as possible. The extra length over that of the shafts allows the washers to be clamped tightly against the bearings to keep the melted metal in place.

Now make the jig or yoke *b*, Fig. 3, by first fitting the two pieces together perfectly, as shown, securing them by two 3-16 in. screws at the ends. The joint must be perfectly straight. Now lay off the holes with centers exactly 3 in. apart and bore to size on the lathe face plate. If the lathe will not swing them, have them bored in some shop, which should cost only a trifle.

When finished two yokes are provided for suspending the mandrels in place and a small ⅛ in. strap secured by three small screws, as shown in Fig. 3 *c*, will hold the mandrels firmly in place. Now lay the mandrels in position in the upper half of the case and adjust them accurately parallel with the center line of the case.


DETAILS OF
TRANSMISSION GEAR.
3 Speeds Forward and Reverse.
THE GRISWOLD COMPANY
Quincy Mass.
Bevel Gears
Ratio 1:1.54
26 teeth. 8 pitch.
40 teeth. 8 pitch.
Fig 3.
Method of Supporting Mandrels in position.
Chain Sprocket. Steel.
12 teeth. 1" pitch.
Hand-hole Cover. Brass.
1/8" thick.
Blotting paper.
Wood ring.
Mandrel.
Fig. 3.
Shifting Rod. Steel.
Gear Shaft. Steel.
Sliding Gear Shaft. Steel.
Main Driving Pinion Steel.
Sprocket Shaft. Steel.
Sliding Gear. Steel.
Reverse Pinion. Steel.
Rev. P. Shaft. Steel Hardened.
Pinions turned, Solid with shaft.
1 1/4" U.S.S. nut.
To suit work.

Clamp the yokes securely at one end, drill a 3-32 in. hole through the opposite end and flange to take a dowel pin, as shown. Then see that the ends of the bearings are properly dammed with a piece of blotting paper held securely against them by a wooden ring forced over the end of the shaft as in Fig. 3 *d*, the ends of the bearings having been previously filed smooth and square, and to the same length in both halves that match. Have the metal quite hot and the mandrels smeared with a very thin film of graphite to prevent the Babbitt metal from adhering thereto. When cold remove the mandrels and file off the top of the Babbitt metal until flush with the joint of the case. Each half is similarly babbitted.

Before pouring the other half, lay them together and put two bolts through opposite holes. Then run the 3-32 in. drill through the undrilled flange, using the already drilled hole as a guide. Now reverse the positions of the yokes on the mandrels so that they may be used on the same ends in each case, and pour the bearings in the remaining half. The dowel pins will thus locate the position of the shafts exactly, so that when the two halves are bolted together the bearing will be a truly cylindrical hole, and the pressure of the bolt will not draw the halves to one side or the other, thus cramping the shaft.

The shaft for the large bevel gear and sprocket may now be linned up. In lining up this shaft the other shaft with its bevel pinion should be in place so that the two gears may be made to mesh exactly. It may be supported in position by two centers made of ½ in. rod fitted in two blocks, as shown in the small sketch, Fig. 3*e*. This enables the two shafts to be turned while setting, and the exact position determined. Of course when the case is machined the trial setting is unnecessary, but for the amateur this method is both quick and accurate. When properly set, dam the bearings with putty and pour in the hot metal, having previously covered the shaft with graphite.

Now chip a small, half round groove, opened at the inside end, in the bottom of each bearing, Fig. 3, *f*, so that the oil will drain to the inside of the case instead of running outside. This is in the bearings of the bottom half only.

In the bearings of the upper half chip a similar groove, but closed at each end. Then drill a ¼ in. hole through to the inside, as shown, Fig. 3 *g*. A ¼ in. brass tube leads into this from the oil trough on the side, thus flooding the bearings with oil. A similar device is used to oil the bevel gear shaft, as shown. The troughs are simply strips of brass bent into a "V" shape and secured to the side by screws passing through. They catch the oil draining down from the inclined top where it is splashed by the gears.

The machine work on the other part requires no particular description, as it is very simple and the gears can be cut at a shop fitted for such work, or they may be purchased already cut. For those not wishing to go to the expense of cut gears, a set of cast gears has been prepared which can be made to run very smoothly by finishing the working faces of the teeth with a file. Of course cast teeth do not work as well as cut, neither are they as strong, but for a light car they do quite well and are cheap. The various details of the gear are shown in Fig. 4.

The length of the shaft attached to the clutch shaft is merely long enough to take a muff coupling, the intermediate length to the clutch being fitted when the gear and engine are in place.

TWIST DRILLS; THEIR USES AND ABUSES.

By Courtesy of the Cleveland Twist Drill Company.

Next to a drill being properly made and tempered, it is of the utmost importance that its cutting edges be properly ground to get the maximum results in drilling. This means that both cutting edges must have the same inclination to the axis of the drill, and be of exactly the same length; this will, of course, bring the center of the cutting edges in the true center of the drill and will produce a round and smooth hole. To get maximum results all these requirements must be carefully observed. It is not sufficient to have one condition correct, but all of them. If the point be central but the angle of the cutting edges different, the drill will bind on the side of the hole opposite to that side of the point which is cutting, will drill too large a hole, and all the work will fall on the one cutting edge. Fig. 8 illustrates this, while Fig. 9 shows a point ground with equal angles but of different lengths, which will result in the hole being too large.

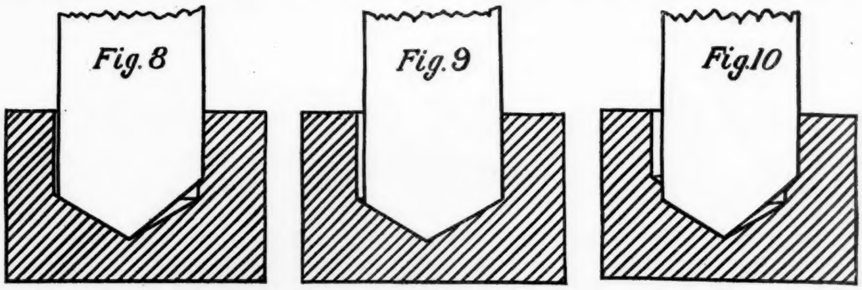
When both angle and length of cutting edges are wrong the drill will be laboring under the severe conditions shown in Fig. 10, and the support spoken of n paragraph on "diametric support" entirely lost.

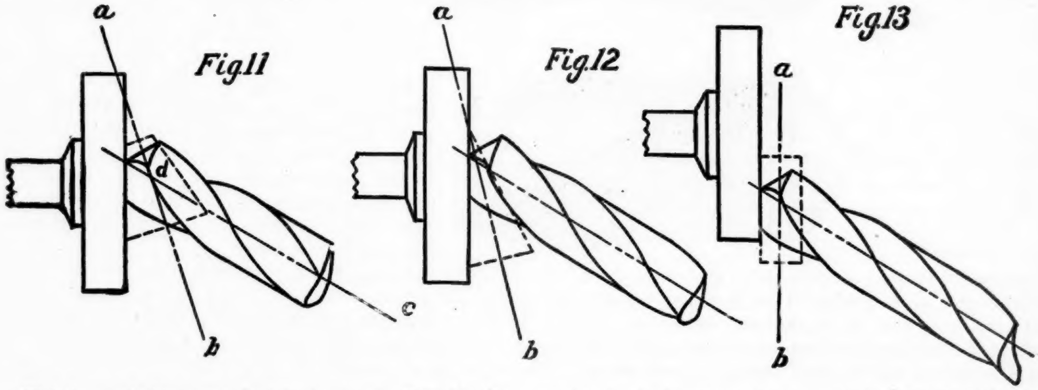
Another very important feature of grinding a dri l point is the lip clearance or proper backing off of the cutting edge. To do this correctly, even on a machine, is a difficult problem. Our idea of the correct form to which the lip of a drill should be ground is that of a segment of a cone whose axis is on line *a b* Fig. 11, and at an angle *b d c* to the axis of the drill. There is, however, a difference of opinion among engineers as to just what shape this end of the drill should be, some favoring that shape which corresponds to a segment of a cylinder, some an inverted cone, and still others a cone of irregular contour.

The machines which grind on the last named system nearly all come under the head of form or cam machines, that is, the shape is produced by copying a template or the motion of a cam.

In Fig. 11 the dotted lines show the complete frustrum of the cone; by comparison that of Fig. 12 will be seen to be too near the center, and the curvature at that point correspondingly more, which we found to consume about 20 per cent more power than that of Fig. 11. Fig. 13 illustrates the point whose surface is a segment of cylinder, and Fig. 14 represents the inverted cone with an axis on line *a b*, dotted lines show the frustrum complete. In both these forms of point. (Fig. 13 and 14) the curvature is too small at the outside periphery compared with that of the inside or center when the clearance angles are correct. Increased durability is claimed for this form of point, due to the support the cutting edge has from the small curvature at the periphery where the most severe work is done. This is probably true, but is in turn offset by the fact that when the curvature at the periphery is correct for good work, that of the center is excessive, and under heavy feed pressure the edge chips out and breaks, evidence of which we are constantly brought in contact with.

There are various shapes of flute and angles of spiral on the drills made by different manufacturers, the shape of flute varying only by a small amount, while the angle of spiral ranges from 18° to 35°.





Theoretically the finer pitch of the spiral grooves or the greater angle of the spiral with the axis, the easier it should sever and bend or curl the chip; but practical considerations arise which counteract the mere saving of chips, and it becomes advisable to make this angle somewhat more acute than would otherwise be the case. Among the practical objections to a very fine pitch of spiral may be mentioned the weakness of the cutting edge and its inability to carry off the heat generated. It also packs up with chips more readily.

From a large number of tests made we have found that the practical limit to this angle of spiral for the regular commercial article is between 30° and 25°, assuming that the average drill is to drill a hole from one to three diameters deep. For deeper holes than this a smaller angle might be advisable, and for shorter holes a greater one. The difference in torsional stress on the drill does not vary any considerable amount when the angle of spiral ranges between 30° and 25° with the axis. We therefore use an angle of 27½° for reasons which facilitate the operation of milling the grooves and to simplify the curves on the cutter, to produce a straight lip of the form shown in Fig. 5. This angle of 27½° with the axis makes the spiral groove of all drills start at the point with a pitch equal to six diameters of the drill blank. This with a uniform web increase retains a strict uniformity in the pitch of grooves, and curves of cutters for the entire system of regular drills

and is the form which our experience has shown to be the most effective for the average work a drill is called upon to do.

The subject of the speed at which a drill should run and the feed per revolution is one on which engineers differ very radically, and the extremes of heavy feed with slow speed and light feed with fast speed are both supported by indisputable data. No rule can be given to cover all cases, and the ordinary tables published should be considered as guides only; the correct speeds should determined by good, sound judgment for

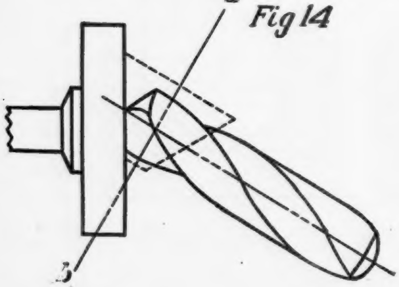


Fig 14

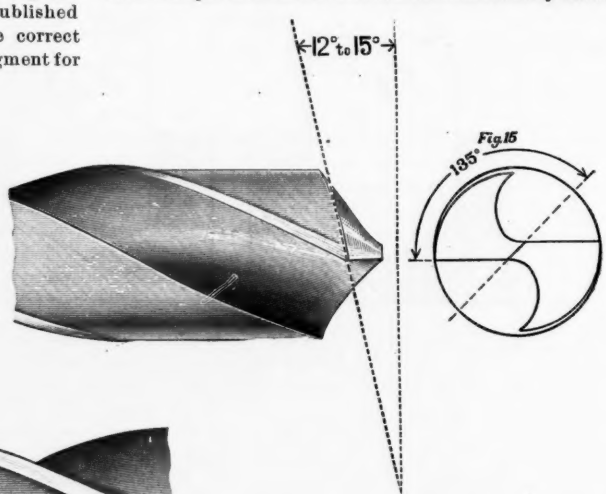


Fig. 15

Fig 16.

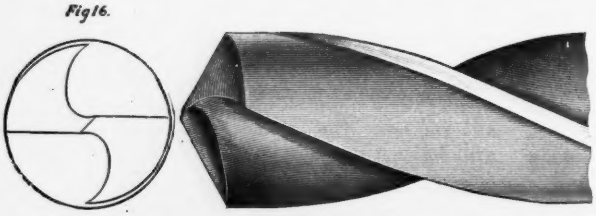
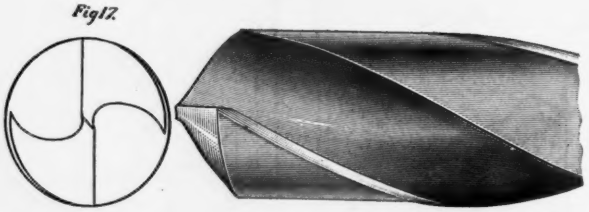


Fig 17.



each particular case. One thing is certain, if the drill chips out at the edge there is either too much lip clearance or too much feed, and a drill split up the web is sure evidence of improper grinding or excessive feed pressure, and no drill manufacturer ought to be expected to replace a split drill unless there is a "flaw" apparent in the break. Fig. 15 illustrates the angle of lip clearance; 12° is the best for the average rate of feed; for heavier feeds this angle may be increased to 15°. Observing the end view of this figure, the center of the drill will be found to be at an angle with the cutting edges, and should be approximately as shown.

The remedy for drills that are properly ground, chipping at the cutting edges is to decrease the feed and increase the speed, which, if a little care is taken to arrange properly, will produce as much work as before, with a longer life to the drill. When the extreme outer corners deteriorate too rapidly, it is evidence of too much speed, so that the best performance of a drill will be found where the effect of the work on the tool is somewhere between these two conditions.

If no table is at hand or operator is in doubt as to correct speed for the drill, start with a periphery speed of 30 feet per minute for soft tool and machinery steel, 45 ft. per minute for cast iron, 60 ft. for brass, and a feed of from .005 to .007 of an inch per revolution, and then attain maximum results by noting conditions of the drill and following instructions in preceding paragraph.

We have seen 50 point carbon steel drilled with one of our 2 in. drills at a periphery speed of 60 ft. per minute and a feed of .005 inch per revolution, but we do not think it is good practice, as we have found in our own work that the majority of cases are better suited to high speed and light feed carried to the point at which the outside corners commence to wear away.

For automatic machines where holes do not exceed two diameters of the drill in depth, and under a flood of lard oil, high speeds and light feeds are especially recommended. For holes deeper than this it becomes a matter of getting rid of the chips, and a form like Fig. 5 is efficient with slower speeds and heavier feeds, as the bottom of the hole is approached. Always endeavor in automatic drilling to get a small compact roll to the chip, and if possible keep it intact the entire depth of the hole.

A heavier feed should be used in drilling brass, especially in automatic machines, to insure chips working out, and if lubricated at all it should be *flooded*.

High speeds in cast iron tend to wear away the small portion of the drill that represents the diameter—see Fig. 2—and we think that 35 ft. per minute should not

be exceeded. Feed may be from .007 in. to .015 in. per revolution, according to the kind of metal drilled.

The drilling of hard material is facilitated by reducing angle of spiral with the axis, as shown in Fig. 16, so as to permit of heavier feed pressure without chipping the edge, and using turpentine as a lubricant, but extreme care and judgment is needed to do this without unfitting the drill for further use. This form of drill will be found efficient in drilling soft material where the regular form has a tendency to "hog in". Drills are made to feed to their work easier by thinning the extreme point. This is a delicate operation and requires some skill on the operator's part, but is a decided improvement in hand feed drilling. To thin this point properly a round face emery wheel is necessary, and the drill should look like Fig. 17 when finished, care being taken to preserve the true center of the drill and not weaken it by extending the ground portion too far back.

CONCLUDED FROM OCTOBER NUMBER.

TOOL MAKING FOR AMATEURS.

ROBERT GIBSON GRISWOLD.

IV. Lathe Tools and Their Cutting Action.

The essential requirements for lathe tools, especially those used for general work, are hardness of cutting edge combined with a toughness in the metal. There are many special uses to which lathe tools are put that require a very hard edge, but such an edge must have very little clearance or the pressure of the work would soon crumble it off. This degree of hardness can be increased by special methods of hardening, to almost that of a diamond, but for the general line of work pursued by the amateur this would result in a great loss of time at the wheel, for the edges will chip off if at all thin. Especially is this true of the self-hardening steels. It is very difficult to put on them a finishing edge that will stay and give to the work a smooth finished appearance, although for the roughing cut they cannot be excelled.

For this reason a great many machinists do the roughing work with self-hardening steels and take the finishing cut with a high-carbon steel such as Jessop's. These tools hold a beautifully fine edge, keen and smooth, especially after being oil-stoned.

The tempering of lathe tools is generally done in the yellows, as noted in the table given in the first chapter. It must be remembered that the soft metals will pull a fine, keen edge into them if much rake or clearance is allowed, and for this reason they should not be left very hard, as this strain will snap off the edge.

The amateur will have need of as large a set of tools as he can afford. In fact, his set should comprise a form for every ordinary operation, to be time-saving. A great deal of time can be lost by attempting to force one tool to perform the work that should be done by one of another form. Thus, a diamond point tool can hardly be used as a thread tool and result in a very fine piece of work. Neither can a side tool be forced to do cutting off satisfactorily.

It has been the aim of the writer to illustrate in this article only the most frequently used and necessary tools, commencing with those used for the more common operations. Other forms will be taken up under the head of special tools.

In the first place, it will be well to consider the grinding of the tool and the terms "rake" and "clearance" and their effect on the resultant work.

In Fig. 1 is shown the action of a tool with a perfectly square edge. It requires a great pressure to force it through the work, and instead of cutting crushes the metal in front of the tool. The action of all cutting tools depends on a wedge action, and the keener the wedge the easier does it become to push it through the work.

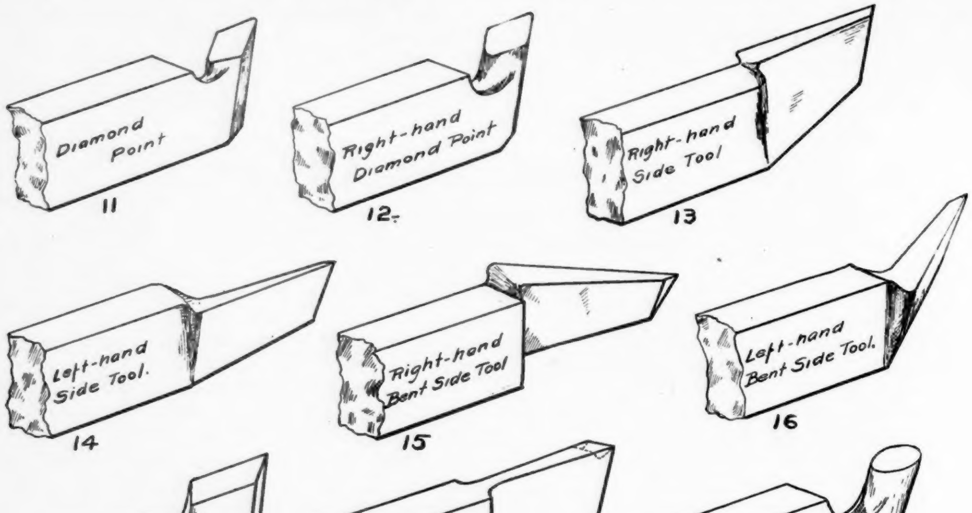
If we decrease the angle *o* in Fig 1, the cutting angle *o* begins to approach a wedge and the advancing face falls away from the perpendicular, making the angle *r*, Fig. 2, less acute. Upon this angle *r* depends the ease of cutting, as the material is then cut off instead of being crushed, as in Fig. 1. But when the angle becomes as acute as in Fig. 3, there is great danger of the edge being cracked off by being forced downward by the pressure of the chip above, as shown by dotted lines, somewhat exaggerated. The angle *r* is known as the "angle of rake."

But when the tool is lying flat on the work, as in Figs. 1, 2 and 3, it is impossible to press the cutting edge into the work, and the chip will continue as started, or the tool will have a tendency to work out. If the metal under the tool is now removed, as in Fig. 4, the cutting edge is relieved and can be pressed into the work, the cutting action remaining the same.

This small angle *c* is called the "clearance angle" and is given to all tools so that the edge may be made to cut as it is fed to the work. But this edge must not be made with too great a clearance or the result will be a tool something like Fig. 5, in which both the rake and clearance are excessive. It can be readily seen how very little support the cutting edge of this tool really has, and with a chip of any thickness the edge would be bent downward and snapped off.

Let us now consider the above principles as applied to the lathe tool. In Fig. 6 is shown the action of a square edge tool when acting upon a circular piece in the lathe. When acting on the center line *a d* it may be fed into the work by exerting a great deal of pressure, which will have a tendency to spring the work. If the tool is raised any above this line it will not cut at all because the edge is above the point of contact, as shown in the dotted position *b*. On the other hand, if this tool is lowered below the center line its action will be that of scraping and the nearer it approaches the position indicated by *c* the greater will be the tendency for the work to spring up and "walk" out onto the tool. This action is especially evident with cutting off tools when the cutting edge is very wide and the stock not stiff enough to hold the work in place.

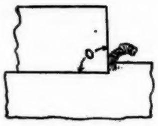
In Fig. 7 the tool has been given top rake so that the chip is cut off more easily, and it also has been given clearance so that it will feed into the work easily. This form of cutting edge is easily preserved by grinding. In Fig. 8 the same tool is shown placed above and below the center line. When placed above the center line the cutting action is very smooth but it



will cut only as long as the point touches the periphery of the piece below the normal to the front of the tool, or the line *oe*. For this reason the tool will not cut to the center unless its position is changed. When the tool is placed below the center line its action becomes a scraping rather than a cutting one as the upper face approaches the perpendicular to the surface, and the condition is similar to that shown in Figs. 1 and 6. The point will surely go in this case if much pressure is applied, as there is no metal beneath to support it.

any, top or side rake, while the tools for iron. steel or cast iron will be provided with a rake varying from 3° to 10° as experience dictates. There can be no set rule for this angle, owing to the varying character of the materials being worked.

Fig. 11 shows the diamond point tool which is, perhaps, used to a greater extent than any other single tool. Its chief work is that of taking a roughing cut, and for this particular work it cannot be equalled. It cannot work up to a shoulder, however, without being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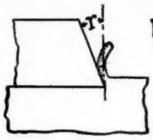
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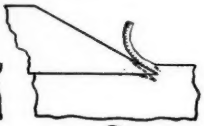
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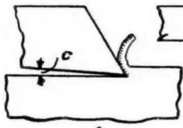
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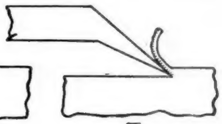
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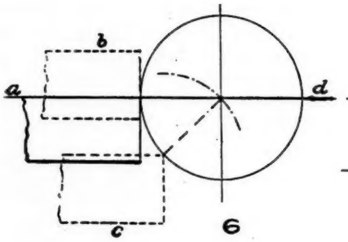

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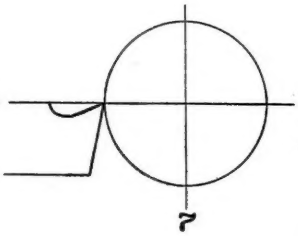
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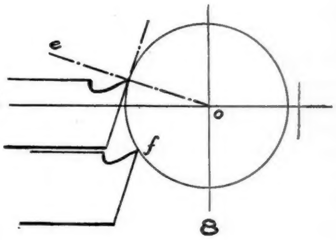

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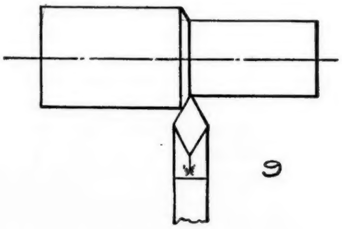
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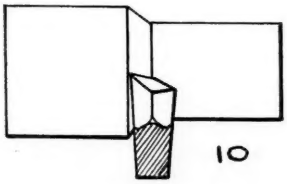
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In Fig. 9 is shown the top view or plan of a diamond point tool working into a cut. This tool is given both top and side rake as shown in Fig. 10, which is a view looking along the stock from the tool post, the stock having been broken away. This also shows the side clearance necessary to enable the tool to advance along the piece being turned.

It is evident then, that in order to make a tool cut easily and reduce the work done by the lathe, the tools should be given top rake when cutting in a radial direction, and side rake, or both, when cutting longitudinally. Also that clearance should be provided both in front and on the sides when the tool is used either for radial cuts, as in a cutting off tool, or on the side, as in a diamond point or side tool. The angle of clearance may vary from 3° to 5°, seldom more. The angle of rake depends upon the quality of metal to be worked, the softer metals, such as lead, babbitt, brass and copper being turned with tools having little, if

set at an angle in the post, and for this reason the right hand diamond point is sometimes provided. They are both given top and side rake, as well as front and side clearance.

In Figs. 13, 14, 15 and 16 are shown the right and left hand side tools, both straight and bent. These are used for finishing the ends of cylindrical pieces and flat surfaces generally that are faced in the lathe. As it often occurs that the straight tool will not conveniently reach the center of the work without bringing the tool post in contact with the work, the side tools are provided for such emergencies. They are given considerable side clearance and the top rake is at least 10°. This gives them a very keen edge that can be honed to render the finished surface perfectly smooth and free from scores or scratches. The work that a well sharpened tool will do when properly set is remarkable. The extreme point should be relieved slightly so that it will not leave a line on the surface,

as a sharp point will sometimes do. No great amount of stock is to be removed with these tools; use a diamond point for that work and finish with the side tool.

The half-diamond point shown in Fig. 17 is in reality a simple form lying between the side tool and the diamond point, and is used principally for cutting to a square shoulder.

In Fig. 18 is shown a cutting-off tool whose purpose is the cutting off of cylindrical pieces in the lathe. It is made deep under the cutting edge to give it the necessary support, while the extreme point is the widest part, the sides being relieved so that the tool will not bind in the groove. Owing to the confined cutting area it is not practicable to give this tool very much top rake, as the cutting edge is decidedly weakened thereby and likely to be broken off. On the other hand, if the edge is left perfectly square it requires considerable work to push it into the metal, and the piece will generally break off before the cut is finished. This can be obviated by making the cutting edge very narrow. The writer uses a tool slightly less than 1-16 in. wide and 1 in. deep for short cuts, say up to ½ in., and for larger pieces up to 2 in., a tool about 3-32 in. wide, with a groove round in the facing edge which breaks the chip into two thin strings which do not bind in this groove and relieve the tool of any great strain. This tool never shows any tendency to run to either side. The thinner the tool the less power required to drive the lathe.

Fig. 19 shows the round nose or filleting tool. Its principal use is for rounding fillets in corners. Several tools of different radii should be made, say 1-16 ⅛, 3-16 and ¼ in.

The thread tool is shown in Fig. 20. The point is made by grinding the face to a certain angle which will make the angle at the cutting edges exactly 50°. This angle varies with the front clearance, but if the tool is once ground correctly so that a 60° gauge will fit the point exactly. This angle varies with the front clearance, but if the tool is once ground correctly so that a 60° gauge will fit the point exactly, the only grinding that should ever be done again to sharpen it is to grind it flat on the top face. The cutting angle is thus preserved and the threads are bound to be exactly 60° between the sides. Sometimes the straight tool cannot be used to a shoulder; the bent thread tool is then brought into use, Fig. 21. It is ground in a similar manner to that shown in Fig. 20.

For finishing turned work the broad nose tool is used. This tool is very difficult to use on account of the chattering that will set up if there is the slightest looseness anywhere in the lathe. In light lathes it is better to use a tool not more than ½ in. wide and have the corners slightly relieved, as shown. The top rake need not be great. It should be used with some fluid such as oil or soda water.

The inside boring and threading tool is shown in Fig. 23. It should be forged to a long, tapering end and the extreme tip bent to the left, as shown. This point is sharpened either as a diamond point or small square point, as shown at *a*, which will work into the corners. In fact, three of these tool should be made, so that the three points shown could be always in readiness. The thread tool is ground to a 60° angle.

In order that a drill may be started in work held in a chuck or strapped to a face plate, a center must be made first. This can best be done with the tool shown in Fig. 24. The edges of the angular point are ground to the drill angle (not always 60° and sometimes as great as 100°) and backed off on opposite edges until they form a drill or, in other words, until both edges will cut when the tool is pressed into the work. When a center has been spotted the drill may be started and it will then follow in the exact center.

The tool shown in Fig. 25 is mostly used for turning brass. It is drawn to a narrow point and may be made either round or square or, better still, two tools should be made. As brass is run at a high speed these tools will remove a large quantity of metal in a very short time and the cutting edges are not provided with top rake on account of the danger of drawing the tool into the work. Clearance is given, however.

JUNIOR DEPARTMENT

For the Instruction and Information of Younger Readers.

ELEMENTARY MECHANICS.

J. A. COOLIDGE.

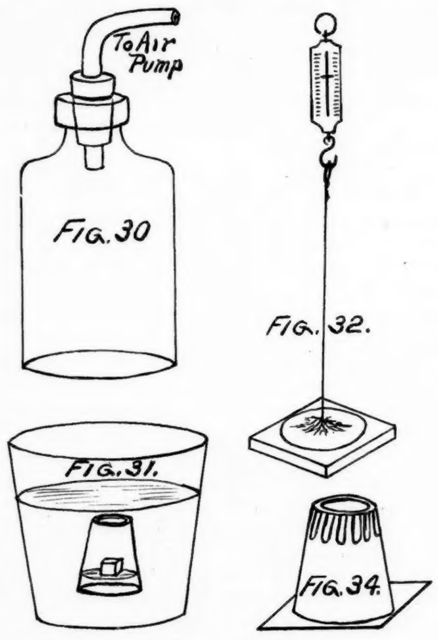
X. Compressed Air.

Gases and liquids, because of their similarity in some respects, are called fluids. They are carried in vessels of any shape, have no difficulty in adapting themselves to the form of vessel into which they are put, and may be forced through pipes many miles in length. They have some points in which they differ widely. While liquids are almost incompressible, an immense force exerted on a cubic foot of water hardly diminishes its bulk so that any difference is noticeable; a cubic foot of air, on the other hand, may be easily made to occupy a space one-half or even one-fourth as large. Then, again, the density of gases is very much smaller than that of liquids. Many solids may be

be found lighter than the lightest liquid, but the lightest liquid is probably as many as a thousand times as heavy as any gas known. Our work in this issue deals with both gases and liquids, some of their characteristics and how they are related.

EXPERIMENT XXVIII.

For all who have a bicycle pump an interesting experiment may be performed illustrating several things. A large. strong bottle, fitted tightly with a rubber stopple, and having a valve from a bicycle tire with the valve stem fitted in, as in Fig. 30, will serve as apparatus. It may be necessary to tie the cork in with a stout thread. First, weigh the bottle with cork and fittings, next, fasten to the pump and pump in several strokes. Weigh again and notice the increased weight. The bottle, filled with condensed air, weighs more than before. Follow out this reasoning and you will see that the bottle, without any air, would weigh less, and that the air in the bottle has a definite



weight. Let some of the air out of the bottle and notice the force with which it escapes. If there were more of it, and the supply could be maintained, almost any kind of mechanical motion might be produced. Recall some of the uses of compressed air. Brakes on cars are made to act, packages are sent flying through pneumatic tubes, and cars are made to go by means of compressed air. Plunge the bottle, filled with compressed air, into a tub of water and again open the valve. Instead of seeing the water enter the bottle the air comes bubbling out. Imagine our bottle to be a tunnel under a river, as we have in Boston, under the harbor. If air is forced into the tunnel and kept there compressed, a small leak will not let water through, because the pressure of air against the hole trying to get out is greater than the force of the water trying to get in. Such a condition is today quite frequent. A diving bell filled with compressed air has the power to prevent the entrance of water from below. A simple illustration of this may be seen in the forcing of an ordinary glass tumbler, inverted, down into a pail of water. See Fig. 31. A little block of wood under the glass makes it more apparent that the water does not enter the glass but is prevented by the air already there.

The air all around us exerts pressure upon all things although, for the most part, this pressure is unnoticed Its pressing force is felt when we try to open a bottle or to take the top off a glass covered fruit jar.

EXPERIMENT XXIX.

Place a small quantity of water in a bottle and then place the bottle in a pan of moderately warm water. Bring the water to the boiling point and when boiling briskly remove from the fire. As soon as the water ceases to boil cork the bottle tightly snd allow it to cool. After it is cool you can see that the cork has been driven deeper into the neck of the bottle, that it requires considerable force to removed it and, that when pulled out, the air rushes in with a slight explosive sound. The air presses upon the cork with a force great enough to push it down into the bottle; the steam, when cooled off, is condensed into water and occupies so much less space than as steam that there is a partial vacuum into which the air rushes when the cork is pulled out.

EXPERIMENT XXX.

A circular piece of thick leather, two inches in diameter, with a string passing through the center and knotted, makes what is known as a "sucker". Make the knot as flat as possible by pounding, soak the leather in water and press it firmly upon a very smooth, flat stone or pane of glass, so that no air shall be left between the leather and the glass. Make a loop in the string and fasten to the spring balance (see Fig. 32) and see how many ounces you can pull before the leather is separated from the glass. Make at least three trials. The air pressure upon the leather is so great that an opposing force still larger must be used to overcome this.

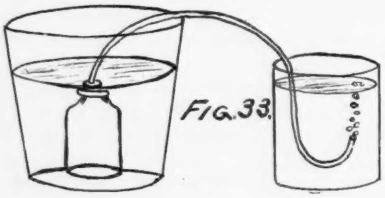
EXPERIMENT XXXI.

The effect of heat upon a body of air may be seen in this experiment. Take the bottle used in Experiment XXVIII., remove the valve from the stem, connect to the stem the rubber tube of the pump after unscrewing it from the pump, and plunge the bottle in a pail of warm water, holding the open end of the tube under water, as in Fig. 33. The heat expands the air and causes it to force its way out through the opening A. This expanded air, being less dense, will rise. The air around a stove being heated rises, and cooler air rushes in to take its place. The products of combustion in our stoves, consisting of heated air and gases

rise, pass out one chimney, and are replaced by cool air coming in at the bottom of the stove. The hot air in the top of a furnace rises because of the pressure it exerts, the cold air comes in to take its place, forcing it up and thus the air is carried through the pipes to the rooms of the house. The expansion of gases due to heat, the pressure of colder, heavier ones crowding down to take their place, explains the principle of chimneys and ventilators.

EXPERIMENT XXXII.

Take a common clay pipe and a thin piece of sheet rubber about two inches square. The rubber can be obtained from any dentist. Tie the rubber with a thread so as to make a diaphragm covering over the



open end of the pipe. By drawing in the breath the air may be removed from the inside of the rubber diaphragm, leaving the air on the outside free to press as it will. No matter what the direction of the bowl of the pipe, the diaphragm is pressed in whenever the air on the inside is drawn out, and returns when the air is allowed to flow in. This experiment. perhaps, better than any other, illustrates the fact that air presses in all directions.

EXPERIMENT XXXIII.

Take a tumbler and a piece of cardboard just covering it. Fill with water, cover the card and invert, holding the hand on the card until level. See Fig. 34. The card does not fall off; the water does not run out. If done correctly considerable force may be used to jerk the card off without causing it to fall. Of course the water and card would fall of their own weight were they not held in place by a larger force pressing up. This upward force must be the air, as there is nothing else there that can do it. We have seen some illustration of air pressure; in our next paper we will try some experiment with siphons, pumps, etc.

A SIMPLE RHEOSTAT.

HENRY C. WALL.

Quite frequently the strength of battery current in use on a given piece of electrical apparatus has to be varied or regulated to meet certain conditions. Unless the amateur possesses a set of resistance coils arranged for easy handling, the task is likely to be a difficult one, especially when the exact amount of resistance to be applied is to be ascertained only by experiment.

The writer not long ago, in connection with wireless telegraph experiments, felt the need of a suitable device with which he could increase or decrease gradually the flow of current in his coherer circuit, and as the device, when completed, gave good satisfaction, a description of it is here given for the benefit of AMATEUR WORK readers. A piece of round hard wood, about one inch and a half in diameter and twelve inches long was procured. Such pieces may be readily purchased at furniture stores where portiere poles are sold.

A small metal binding post was fastened to one end of the piece. A piece of No. 30 German silver resistance wire was soldered to the binding post. If the German silver wire is not to be had in your vicinity the same gauge of bright steel wire will suffice. Fastened at the binding post along with the wire is one end of heavy silk thread, or black linen might answer. The thread and the wire are to be wound around the wooden cylinder, parallel with one another, so that at all times an insulating thread is between the wire turns. In this way, by winding evenly, a good amount of resistance wire may be placed in a space. The entire winding is then given a very thin coat of shellac and when thoroughly dry, the wire brightened by rubbing with an old piece of fine sand paper.

The amateur will now observe how this coil, when inserted in a circuit, may be used as a veritable resistance, to be determined by the portion of the coil that is included in the circuit.

It is necessary, therefore, to provide a sliding contact to slip back and forth as desired. This may be made of a block of wood with a 1¼ in.hole in it, or of fibre tubing. Inside the tubing is placed a strip of spring brass, bent inward in such a position that the wire wound on the cylinder is rubbed by one end of the brass strip as the "rider" is moved back and forth, and to this rider is soldered another binding post. Whenever this device is introduced in a circuit, the amount of current is varied according to the amount of resistance; that is, the number of resistanoe wire turns included in the circuit.

Instead of using a cylindricsl rod, the amateur might cut out a thick ring of pine or other wood and use one-half, one-quarter, or as much of the curve as desired, to wind on, and instead of the riding contact described above, arrange a swinging wipe contact similar to the switch arm used on ordinary single piont switches. This would entail additional work, however, and unless the amateur is provided with tools suitable for cutting out the circle, it is advisable to follow the simpler method.

The Goodell-Pratt Co., Greenfield, Mass., have long been known to the trade as manufacturers of labor saving tools of the highest grade. The tool set advertised in this issue is but one of the many tools which the amateur mechanic or electrician will find useful in his work. The catalogue of this company, which may be obtained upon request, shows hand and bench drills, chucks, bit braces, gimlet bits, and many other tools.